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RESEARCH BULLETIN

DIGIT SPAN AND ALPHA FREQUENCY: A CROSS-VALIDATION

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Digit Span and Alpha Frequency: A Cross-Validation

Abstract

Evidence is adduced supporting two propositions involving the relation of individual Wechsler subtest scores to "normal level." (1) Brain-damaged subjects perform on Digit Symbol at least 2 WTS points below their apparent normal level. (2) A positive relation exists between the difference score, Digit Span minus normal level, and the frequency of the occipital EEG for non-brain-damaged subjects.

Digit Span and Alpha Frequency: A Cross-Validation[1]

Introduction

The results of a recent factor analytic study involving both EEG and Wechsler variables (8) have suggested that the Digit Span (D) subtest of the Wechsler and the alpha frequency (aF) observed in the EEG have much in common. More precisely, we hypothesize that the partial correlation between measures of D and aF will be attenuated only by unreliability of measurement, when "general intelligence" is held constant in a sample that is homogeneous in age and free of brain damage. Such a hypothesis is consistent with directly relevant data reported by Shure and Holtzer (9), and may be readily reconciled with the excitability cycle conception of the alpha rhythm (4). On the other hand it appears difficult to reconcile this hypothesis either with Mundy-Castle's linkage of "primary function" with high aF (5, 6, 8), or with Kennedy's electromechanical explanation of the alpha rhythm (3). It is the purpose of this paper to report the result of a test bearing directly on the stated hypothesis.

Method

EEG tracings and Wechsler performance profiles were obtained for a total of 71 male cases,[2] none of whom were included in any previous study. This group represents almost every case referred for diagnostic EEG examination over a period of time, who were invariably suspected of brain damage. Actual primary diagnoses of chronic brain syndrome (CBS) or acute brain syndrome (ABS) were subsequently assigned by the hospital staff to about

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[2] We are indebted to Dr. John E. Davis, Jr., for assisting in the collection of these data at the Lexington Veterans Administration Hospital, Kentucky.

one-fourth of these cases, without reference to the Wechsler scores, which were often obtained only as a result of our request for data.

In order to avoid placing needless reliance on the particular diagnoses available for this sample, we employed a simple psychometric procedure to select a sub-sample that would be free of the complicating influence of brain damage. This procedure is based on the proposition that brain-damaged subjects perform on the Digit Symbol subtest (DS) at least 2 WTS points below their own normal level (NL).[3] The validity of this proposition is indicated by the following frequency distribution of cases:

	DS < NL - 1	DS = NL ± 1	DS > NL + 1
Diagnosed CBS or ABS:	14	2	0
Diagnosed epileptic:	0	3	0
Other diagnoses:	28	20	4

On the basis of this evidence it would appear that we may avoid difficulty that might arise from undiagnosed brain damage by restricting our attention to cases for which DS $\geqslant$ NL - 1. It does no harm that we may also be eliminating cases without brain damage. We are left with 29 cases.

We estimated aF by inspection of the original EEG tracings, looking only at the left occipital portion of the record and paying particular attention to the early part of the record before the subjects had either gone to sleep or been subjected to diagnostic stimulation. A sample of our estimates of aF were compared with those made by an independent judge, and found to agree within one-quarter cps. as a limit of error. All our

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[3] Normal levels were computed from each Wechsler profile by summing the WTS scores for I, C, D, A. S, PA, PC, and BD, then subtracting the WTS score for OA, and finally dividing by 7. The resulting estimates have been used in this study to assess general ability in a manner that appears meaningful in the context of profile analysis. The definition of NL given is the most satisfactory formulation we have yet found in an effort to provide a baseline for consideration of deviations of the individual Wechsler subtests. A more extensive rationale is given elsewhere (7).

estimates of aF were required to fall within the range 8 to 13 cps., although we noted in several instances that the dominant EEG frequency fell outside of these limits.

We held the effect of general intelligence constant by forming the difference between D and NL. Although five of the 29 Wechslers were WB-I and the others were WAIS, the WAIS standardization was used throughout to convert raw D performance into the WTS metric for comparison with NL. D minus NL was correlated with aF, using the sub-sample of cases judged to be free of brain damage, and the product-moment formula. In view of the smallness of the sample, the age variable was left uncontrolled and no corrections for attenuation were attempted.

Result

The correlation between D - NL and aF was found to be +0.40; this correlation is in the expected direction and is "significant at about the 2% level" by a one-tailed test.

Discussion

Although based on a limited sample of cases, the result provides distinct support for the basic hypothesis. At the same time, however, we may note that an even higher correlation can be obtained from our data by using dominant frequency instead of aF. This suggests that restricting the range within which an EEG wave is called "alpha" is essentially arbitrary. While it may serve a convenient purpose in distinguishing what is "normal" from what is "abnormal," it should not be permitted to restrict our thinking about the meaning of the EEG. For most of our cases the dominant frequency did fall within the conventional alpha range. However, the three diagnosed epileptics, who were accepted in the sub-sample, all had low scores for D minus NL. Another case which had a dominant frequency of about 15 cps. also had the highest score for D - NL in the whole sample. Thus, the reported correlation of .4 may have been spuriously shrunken by the restricted range allowed for aF.

Incidental to our main concern, we have stated and partially validated a proposition relating non-epileptic brain damage to the level of Digit Symbol performance in an individual Wechsler profile. While there is abundant precedent for looking at DS for this purpose (1, 10), attempts at cross-validation have often yielded equivocal results (2). Our formulation involving the difference between DS and NL, independently of the rank of DS in the profile, may yield more consistently interpretable results. Certainly, if a score of -2 or less on DS - NL had been required in the present sample as a prerequisite for EEG examination, one-third of the effort spent with the EEG could have been saved while placing only 3% of the diagnoses in jeopardy. Since both of the "jeopardized" cases contribute effectively to the reported correlation between D - NL and aF, the diagnoses themselves may be open to question.

Summary

Evidence is adduced supporting two propositions involving the relation of individual Wechsler subtest scores to "normal level." (1) Brain-damaged subjects perform on Digit Symbol at least 2 WTS points below their apparent normal level. (2) A positive relation exists between the difference score, Digit Span minus normal level, and the frequency of the occipital EEG for non-brain-damaged subjects.

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